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Abstract

**ONE-VELOCITY NEUTRON DIFFUSION CALCULATIONS BASED
ON A TWO-GROUP REACTOR MODEL**

by

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In evaluating critical dimensions and flux distributions in multiregion nuclear reactors it is advantageous to have a method that retains computational simplicity of one-group treatment and yet approaches the accuracy attainable with a two-group model. Such analytically simple but sufficiently accurate representations of the flux equations are particularly important in dynamic studies when it is necessary to obtain simultaneously the solution of the flux equation and its adjoint on an analog computer.

The paper describes a procedure by which the flux distribution can be represented with an expression of the form:

$$F^i(r) = F_1^i(r) + Z_i^i F_1^i(R_i) \exp[-V_i^i(R_i - r)] + Z_{i-1}^i F_1^i(R_{i-1}) \exp[V_{i-1}^i(R_{i-1} - r)]$$

where $F_1^i(r)$ is the solution of the one-group diffusion equation in the i -th region of the reactor, defined by the interval: $R_{i-1} \leq r < R_i$, while Z_i^i , Z_{i-1}^i , V_i^i , and V_{i-1}^i are constants.

At each interface between two regions, the function $F_1^i(r)$ must satisfy a boundary condition defined by:

$$\lim_{r \rightarrow R_i} \frac{dF_1^i(r)}{dr} - \frac{1}{F_1^i(r)} = U_i^i$$

In deriving this expression a one dimensional two-group reactor model, adapted for solution on an analog computer, is used. The two-group diffusion equations are transformed into Riccati equations with associated initial and boundary conditions. Using the properties exhibited by the solution of Riccati equations, the multiregion reactor is reduced to only two regions, involving a simple set of equations which determine the critical dimensions and the coefficients:

$$Z_i^1, Z_{i-1}^1, V_i^1, V_{i-1}^1, U_i^1$$

for all regions.

The normalized set of these equations can be solved once for all, whereby a family of curves is obtained, from which critical dimensions and coefficients can easily be determined for various reactor parameters.

This procedure is applicable to both spherical and cylindrical geometry and to any arrangement of active zones and reflectors. The practical application and accuracy of this procedure is discussed in specific examples.